Optimization of patient dose and image quality for Computed tomography examination

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Abstract

Computed tomography (CT) represents nowadays a very essential and precise tool to define exactly the different kinds of tumors and make detailed pictures of parts of the body taking into consideration that Computed tomography (CT) delivers substantially radiation dose and risk of cancer than alternative imaging methodologies, particularly in children. In the United States, of approximately 600,000 abdominal and head CT examinations annually performed in children under the age of 15 years, a rough estimate is that 500 of these individuals might ultimately die from cancer attributed to the CT radiation.

There are two purpose of this survey; the first was determination of patient dose by using ionization chambers, the second is to measure the degree of accuracy image quality for each protocol. Estimation of the best protocols that can be used in diagnostic centers according to the international CT dose a limit which does not affect the image quality.

The standard head and body phantom in combination with longitudinal ionization chamber dedicated for CT dose were used to measure the computed tomography dose index (CTDI) and dose length product (DLP) for the selected protocols. The X-ray tube potential range 80,100and 120 kVp, time - current tube range 50 to 250 mAs and the scan mode utilized for the measurements is the helical scan.

Our results reveals that there is a good matching between the values of CTDIvol data obtained from the CT scanner and the measured value, within the range from 4 % to 11 %. The CTDIvol for head scan were varied from 3.1 to 35.1 mGy, from 4 to 51.9 mGy and from 5.6 mGy to 73.8 mGy at 80, 100 kVp and 120 kVp respectively at various mAs. For abdomen scan the CTDIvol were varied from 0.8

mGy to 18.7 mGy, from 1.3 to 30.1 and from 1.3 mGy to 51.3 mGy at 80, 100 kVp and 120 kVp respectively at various mAs.

The DLP for head scan were varied from 52.9mGy.cm to 295.6mGy.cm and from 88.7mGy.cm to 459.9mGy.cm at 100 kVp and 120 kVp respectively at various mAs. The DLP vary from 28.9mGy.cm to 149.2mGy.cm and from 48.6mGy.cm to 256.6mGy.cm at 100 kVp and 120 kVp respectively at various mAs for body scan.

If the tube voltage decreased from 120 to 100 kVp at constant tube current, the dose reduced by factor 20% to 50% without pronounced effect on the image.

The present work highlights the need for national studies to understand how the clinical CT factors contribute to variation in dose and assess the relationship between image quality and radiation dose. There is an urgent need to determine the optimum dose for each type of examination that balances image quality, with keeping the dose as low as possible. The effective dose calculated using the scanner-provided DLP measurement can be used as an easy starting point to begin to record patient-level exposure. Similarly, a simple method can be used to estimate the risk of cancer.

Summary

The standard head and body phantom in combination with longitudinal ionization chamber dedicated for CT dose were used to measure the computed tomography dose index (CTDI) and dose length product (DLP) for selected protocols at different scan parameters .

Fifteen computed tomography scanners were chosen to involve in this study. The x-ray tube potential range is from 80 to 120 kVp, time - current tube range is from 50 to 250 mAs and the scan mode utilized for the Multi-slice helical scan at two CT examination (Routine Head and Routine Abdomen).

Evaluation of the volume C T dose index ($CTDI_{VOL}$) and the Dose – Length product (DLP) at different physical parameters (kVp – mAs) and perform quality control tests for CT scanners. Compare between the values of $CTDL_{VOL}$ which measured by electrometer and recorded by operator's console.

Comparison step between our measured verification data which is taken by ionization chamber and data obtained from the CT scanner, within the range from 4 % to 11 %. For head scan, the average effective dose was ranged from 0.11mSv to 0.96 mSv with an average 0.46 mSv, and the corresponding attributable risk of cancer was 0.0026 cancers per 10,000 patients (ranged from 0.0006 to 0.005 cancers per 10,000 patients). For body scan, the effective dose was ranged from 0.43 mSv to 3.85 mSv with an average 1.81 mSv, and the corresponding attributable risk of cancer was 0.01 cancers per 1000 patients (ranged from 0.00243 to 0.021 cancers per 1000 patients). If the tube voltage decreased from 120 to 100 kVp at constant tube current, the dose reduced by factor 20% to 50% with acceptable image quality

The radiation exposure associated with CT has increased substantially over the past two decades, and efforts need to be undertaken to minimize radiation exposure from CT, including reducing unnecessary examinations, reducing the dose per study, and reducing the variation in dose across patients and facilities. Patient outcomes studies are needed to highlight the benefits expected from the examinations and reducing or preventing the associated health risk. Understanding exposures to medical radiation delivered through actual clinical studies is a crucial first step toward developing reasonable strategies to minimize unnecessary exposures.